THE FLIGHT OF VESPINE WASPS IN RELATION TO STORMY WEATHER

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In the course of a series of observations and experiments on the physiology of flight mechanisms of the Vespine wasps, it was noted that flight activities came to a halt upon the onset of rain. During the summer of 1950, it was decided to study the cause of this phenomenon.

A test colony of *Dolichovespula arenaria* F. was established in a laboratory, near a permanently opened window, but away from direct sunlight. Within a foot of this colony was a set of meteorological instruments including a barometer, wet and dry bulb hygrometer, and (in the sunlight)a foot-candle meter. The location of the laboratory in Windsor, Mass. is of such altitude and topography that it lies in the path of many local thunderstorms. Advantage was taken of this fact to record data involving wasp flight in relation to meteorological changes.

It was originally assumed that the wasps had some receptor mechanisms which might warn them of impending bad flying weather. Therefore much attention was placed upon the phenomena just preceding storms. Attempts to relate normal daily flight rates with the small barometric changes preceding rainfall were a failure because there were no changes in the rate of flights. Similarly, all phenomena of the approaching storm (relative humidity, temperature decrease, and light decrease) were impossible of correlation with daily flight rates. It is now apparent that these weather phenomena are inoperative in influencing wasp flight. This is reasonable, because each phenomenon is of common occurrence and is not necessarily associated with approaching precipitation. Further, neither the light nor the temperature reaches a point below the flight thresholds as determined by the author (1).

It might be expected that changes in barometric pressure might be the greatest influencing factor in curtailing flight (if any single factor could be interpreted as an omen of bad weather by the wasps). The greatest barometric change noted upon the approach of a thunderstorm was – 0.23 inches. Since this pressure change is equivalent to an altitude change of about 160 feet, and since it is known that the wasps frequently attain this altitude above ground level in their normal flight, the possibility of such a barometric change causing a change in flight rate can be safely ruled out. This lack of anticipation of approaching storms may serve a useful purpose. There are many days of overcast and impending bad weather, when most meteorological instruments can be interpreted as indicating an approaching storm. On such days, it would impede the efficiency of the colony if all the ergates were to remain within the nest, and no fresh food were to be brought from the field.

The foregoing does not imply that the wasps are unequipped with receptor mechanisms for the various meteorological phenomena discussed. It is known that they are equipped to detect at least some of these weather changes. Newton (3) has shown that the campaniform sensilli of the honey-bee may detect changes in atmospheric pressure. The author has shown (loc. cit.) Vespine sensitivity to light and temperature changes. Moreover, Homann has demonstrated (2) that the ocelli of a number of insects, including *Formica,* are sensitive to very small changes in light intensity. It can thus be concluded that since Vespine wasps have some receptors for the weather phenomena discussed, they cannot, or do not, integrate the various sensory stimuli in such a way as to predict a storm.

As a check, it was decided to duplicate insofar as possible the electrical effects of a thunderstorm. Two, three inch square, sixteen mesh copper wire screens were attached to the cage entrance (one above and one below), so the wasps were forced to fly between the screens. The screens were placed 7 cm. apart. It was then determined that a potential of 100 kilovolts was required to start an arc of this length. Since potentials of this magnitude seldom exist, short of proximity to a direct lightning discharge, a potential of 9.5 kilovolts was placed on the screens. The presence of this charge, regardless of polarity of the screens, induced no apparent restriction in wasp flight. The same negative result was obtained on both clear and rainy days. It is therefore apparent that the dielectric effect of air during an electrical storm has no notable influence upon the activities of the Vespine wasps.

The final attempt to duplicate the effects of an electrical storm was the application of radio frequencies to the copper screens. It is known that the lightning discharges generate an untuned radio frequency wave. The experimental radio frequencies were generated by a crystal controlled Hartley circuit, with assorted frequency doubler and quadrupler output circuits, applied to the screens through co-axial cables. The frequencies used were: 8.3 megacycles, 16.6 mc. and 66.4 mc. The power was constant at 20 watts R.F. Since these experiments had no effect in curtailing the wasp flights, an untuned 10 watt R.F. oscillator was built and employed to activate the screens. There was still no reduction in wasp flights. Each application of these radio frequencies was tried a number of times in all weather.

Both the R.F. and the electrostatic experiments were run for continuous periods of ten minutes. When these were found without effect, momentary applications of these agents were tried, still without effect. In no instance were both agents in simultaneous use. It was concluded that either the wasps could not detect the presence of these agents, or they did not associate them with oncoming storms.

It was noted, during periods of actual precipitation, when flights had come to a halt, that the wasps made sporadic flight attempts at the rate of perhaps one flight every four to six minutes. These flights always concluded with a quick return to the nest, the total round trip seldom exceeding six feet. Thereafter data was analysed with wasp flight related to actual precipitation. While wasps may disregard the warning signals of an approaching storm, it was quickly discovered that they were activated by the falling of actual rain.

As soon as precipitation had begun, the wasps crowded homeward. Outward flights stopped upon the advent of rain at the site of the nest. Observations in the field showed that the wasps would fly homeward when it rained, even though it had not yet begun raining at the nest site. Four or five minutes after the beginning of a rainfall, all flights would come to a stop, indicating that all wasps who could attain the nest had already returned.

Immediately after the end of a short rainstorm there was a rush of six to ten ergates to the nest. These were probably survivors of those who had been beaten down by the rain before reaching home. This was the observed pattern of behavior of three nests during six thunderstorms and one 36 hour rainfall, except that there were no returning stragglers after the 36 hour rainfall.

It appears that the occasional flight of an individual worker during the rain is a sort of test flight to ascertain weather conditions. Upon the cessation of the rain, the first flying worker does not immediately return to the nest, but continues on a normal foraging flight. Therefore this wasp cannot communicate her findings about the improved weather to the nestmates. Immediately after the inauguration of this successful flight, however, the wasps begin streaming out of the nest on their regular duties. Perhaps the failure of the first wasp to reappear is the signal of clement weather. Frequently, the wasps that are resuming their interrupted work are encountered, on leaving the nest, by the returning stragglers. It is significant that the wasps do not resume flight precisely upon the termination of rainfall. There is a time lapse between the end of the rain and the first flight which is within the normal periodicity of the regular test flights.

In conclusion, changes in temperature, relative humidity, barometric pressure, light intensity, electrostatics and radio frequencies (all of which accompany some types of storms) cause no anticipation of bad weather as demonstrated by a change in flight rate among the Vespine wasps. Wasps react to a storm only when they get wet. Some wasps are so unprepared for a storm that they are overtaken and beaten down by the rain. The wasps make regular experimental flights during a storm. These flights are of short duration and distance. The function of these flights is to forage for field products, but the rainfall drives the wasp back into the nest. It has been shown that the wasps are probably equally unable to detect the end of a rainfall.

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